

CLAIMS

1. A lighting unit comprising a light guide plate, a light source, and a truncated pyramid arranged between the light guide plate and the light source, said
5 truncated pyramid having a base, a top smaller than the base, and a slope extending between said base and said top, said light source being arranged in close contact with said top of the truncated pyramid, said light guide plate being arranged in close contact with said base of
10 the truncated pyramid, so that light is propagated from a light emitting part of the light source to the light guide plate without passing through any air layer.

2. A lighting unit according to claim 1, wherein said truncated pyramid and said light guide plate are
15 integrated with each other, and the light source is attached to the truncated pyramid.

3. A lighting unit according to claim 1, wherein said light source and said truncated pyramid are integrated with each other, and the truncated pyramid is
20 attached to the light guide plate.

4. A lighting unit according to claim 1, wherein: if the refractive index of the truncated pyramid is n and an angle between the slope and a line parallel to an axis of the truncated pyramid is α , the angle α of the slope
25 of the truncated pyramid is equal to or greater than $\arcsin(1/n)$.

5. A lighting unit according to claim 1, wherein: if the refractive index of the truncated pyramid is n and an angle between the slope and a line parallel to an axis of the truncated pyramid is α , the angle α of the slope
30 of the truncated pyramid ranges from 30° to 45° .

6. A lighting unit according to claim 5, wherein the truncated pyramid comprises an adhesive member.

7. A lighting unit according to claim 1, wherein
35 the truncated pyramid is joined with the light guide plate by an adhesive member and assuming that the

- refractive index of the adhesive member is n and an angle between the slope of the adhesive member and a line parallel to an axis of the truncated pyramid is α , the angle α of the slope of the truncated pyramid is equal to or greater than $\arcsin(1/n)$.
- 5 8. A lighting unit according to claim 1, wherein the light emitting part of the light source is smaller than or equal to the top of the truncated pyramid.
- 10 9. A lighting unit according to claim 1, wherein the light emitting surface of the light source is smaller than or equal to the top of the truncated pyramid.
- 15 10. A lighting unit according to claim 1, further including a reflecting member placed to at least partially surround the light source and the truncated pyramid.
- 20 11. A lighting unit according to claim 1, wherein a light absorbing member is located near a border between the light guide plate and the truncated pyramid.
- 25 12. A lighting unit according to claim 1, wherein the light source comprises at least one LED.
- 30 13. A lighting unit comprising a light guide plate, a light source, and a truncated pyramid arranged between the light guide plate and light source and formed as a wedge-shaped member, a base of the truncated pyramid being joined to or placed in close contact with the light guide plate, said light source and the truncated pyramid, and wherein a reflecting member is placed to surround the light source and the truncated pyramid, and a light absorbing member is located near a border between the wedge-shaped member and the light guide plate.
- 35 14. A display device including a lighting unit according to one of claims 1 to 13, and a display element.
15. A lighting unit comprising: a light source; a first light guide plate receiving light emitted by the

light source; a second light guide plate receiving light passing through the first light guide plate; and a light converging means located between the first light guide plate and the second light guide plate, the thickness of the second light guide plate being greater than the thickness of the first light guide plate.

16. A lighting unit according to claim 15, wherein the light converging means is a portion including a slope lying between the first light guide plate and the second light guide plate, and assuming that a total reflection angle of the second light guide plate is θ_c and the angle between the slope and a line parallel to an axis of the second light guide plate is α , the relationship of $\alpha < 1.5\theta_c$ is established.

17. A lighting unit according to claim 16, wherein the portion including the slope and serving as the light converging means is an integral part of the second light guide plate narrowed towards the first light guide plate.

18. A lighting unit according to claim 17, wherein the portion including the slope and serving as the light converging means is an integral part of the first light guide plate fanning out towards the second light guide plate.

19. A lighting unit according to claim 15, wherein the light converging means comprises a reflection plate having a slope inclined from a point on or near the end of the first light guide plate to a point on or near the end of the second light guide plate.

20. A lighting unit according to claim 15, wherein the light converging means comprises a generally cylindrical member.

21. A lighting unit according to claim 15, wherein prisms are formed on one side of the second light guide plate, and a polarizer is bonded to the opposite surface of the second light guide plate via a low refractive index layer.

22. A display device comprising the lighting unit according to one of claims 15 to 20; a polarizer bonded to the second light guide plate via a low refractive index layer having refractive index smaller than
5 refractive index of the second light guide plate, and a display panel bonded to the polarizer.

23. A display device according to claim 22, wherein the display panel is a reflective type liquid crystal display panel.

10 24. A display device according to claim 23, wherein the display panel is a vertical alignment type liquid crystal display panel.

25. A display device comprises: a light source; a light guide plate receiving light emitted by the light
15 source; and a light converging means located between the light source and light guide plate, a thickness of the light source being greater than a thickness of the light guide plate, said light converging means being arranged to improve the degree of parallelism of light emitted by
20 the light source and entering the light guide plate.

26. A liquid crystal display device comprising: a light source; a light guide plate receiving light emitted by the light source; a liquid crystal panel; and a polarizer interposed between the light guide plate and
25 the liquid crystal panel, the light guide plate, the polarizer, and the liquid crystal panel being bonded to one another;

wherein the light guide plate has an incidence surface on which light emitted by the light
30 source falls; a light guide area corresponding to a display area of the liquid crystal panel, a first surface at which light traveling in the light guide area leaves the light guide plate toward the liquid crystal panel
prisms formed on a second surface on the opposite side of
35 the first surface of the light guide plate, and an unnecessary light removing area arranged between the incidence surface and the light guide area for removing

at least part of unnecessary light entering the light guide plate at an angle greater than a total reflection angle of the light guide plate.

5 27. A liquid crystal display device according to claim 26, wherein a means for removing unnecessary light is located in the unnecessary light removing area, the means for removing unnecessary light comprising a light absorbing means.

10 28. A liquid crystal display device according to claim 27, wherein the light absorbing means comprises a polarizing member.

15 29. A liquid crystal display device according to claim 28, wherein the polarizing member is an extension of the polarizer extending outwards beyond the display area of the liquid crystal panel.

20 30. A liquid crystal display device according to claim 29, wherein another polarizing member is located on the side of the light guide plate opposite to the side thereof adjoining the extension of the sheet polarizer.

25 31. A liquid crystal display device according to claim 26, wherein the unnecessary light removing area contains none of the prisms located in the light guide area.

30 32. A liquid crystal display device according to claim 26, wherein, if a thickness of the unnecessary light removing area of the light guide plate is t and a width of the unnecessary light removing area is W , the relationship of $W > 2.0t$ is generally established.

35 33. A liquid crystal display device comprising: a light source; a light guide plate on which light emitted by the light source falls; a liquid crystal panel; and a polarizer arranged between the light guide plate and the liquid crystal panel, the light guide plate, the polarizer, and the liquid crystal panel being bonded to one another;

 wherein the light guide plate has an incidence surface on which light emitted by the light

source falls, a light guide area corresponding to a display area of the liquid crystal panel, a first surface at which light traveling in the light guide area leaves the light guide plate toward the liquid crystal panel, and prisms formed on a second surface opposite to the first surface,

wherein in a portion of the prisms lying over a distance corresponding to approximately three times greater than a thickness of the light guide area and starting from the end of the prisms on the side of the incidence surface, each prism having a slow slope and a steep slope, the slow slope having an inclination of 1° or more with respect to a light discharging surface of the light guide area.

34. A liquid crystal display device comprising: a light source; a light guide plate on which light emitted by the light source falls; a liquid crystal panel; and a polarizer arranged between the light guide plate and the liquid crystal panel, the light guide plate, the polarizer, and the liquid crystal display being bonded to one another;

wherein an absorption axis of the polarizer is oriented generally perpendicular to an incidence surface of a light guide area or at an inclination within generally 45° with respect to a direction perpendicular to the incidence surface.

35. A liquid crystal display device according to claim 34, wherein the absorption axis of the polarizer is oriented generally horizontal to the display on the liquid crystal panel or at an inclination within 45° with respect to the horizontal, and an incidence surface of the light guide plate is located near a right side or a left side of the liquid crystal display device.

36. A liquid crystal display device comprising: a light source; a light guide plate on which light emitted by the light source falls; a reflective type liquid crystal panel; and a polarizer arranged between the light

guide plate and the liquid crystal panel, the light guide plate, the polarizer, and the liquid crystal panel being bonded to one another;

5 wherein the guide plate has an incidence surface on which light emitted by the light source falls, a light guide area corresponding to a display area of the liquid crystal panel; a first surface at which light traveling in the light guide area leaves the light guide plate toward the liquid crystal panel, and prisms formed
10 on a second surface opposite to the first surface of the light guide plate,

 wherein, if the refractive index of the light guide area is n_g , the refractive index of a layer formed on the liquid crystal panel from which light
15 propagated through the light guide plate is reflected is n_a , a pitch between adjoining prisms is P , and a distance between the prisms and a reflecting mechanism included in the liquid crystal panel is D , the following relationship is established.

20
$$\sqrt{n_g^2 - n_a^2} / n_a \geq 0.5 (P/D)$$

37. A liquid crystal display device comprising: a light source; a light guide plate on which light emitted by the light source falls; a reflective type liquid crystal panel; and a polarizer arranged between the light
25 guide plate and the liquid crystal panel, the light guide plate, the polarizer, and the liquid crystal panel are bonded to one another;

 wherein a first low-refractive-index layer having refractive index lower than that of the light
30 guide plate is arranged between the polarizer and light guide plate, and a second low-refractive-index layer having refractive index lower than that of the light guide plate is arranged between the liquid crystal panel and the polarizer.

38. A liquid crystal display device comprising: a
35 light source; a light guide plate on which light

emanating from the light source falls; a reflective type liquid crystal panel; and a polarizer arranged between the light guide plate and the liquid crystal panel, the light guide plate, the polarizer, and the liquid crystal panel being bonded to one another;

wherein one side or both sides of the polarizer is formed in an uneven surface.

39. A liquid crystal display device comprising: a light source; a light guide plate on which light emitted by the light source falls; a liquid crystal panel; and a polarizer arranged between the light guide plate and the liquid crystal panel, the light guide plate, the polarizer, and the liquid crystal panel being bonded to one another;

wherein the polarizer and the light guide plate are bonded to each other with a first bond layer, the liquid crystal panel and a polarizing layer of the polarizer are bonded to each other with a second bond layer and, with respect to at least one of the first bond layer and the second bond layer, if the thickness of the bond layer is T and a size of dust caught in the bond layer is S , the following relationship is established.

$$S < 50 \mu\text{m} \quad \text{or} \quad S < T$$

40. A liquid crystal display device comprising: a light source; a light guide plate on which light emitted by the light source falls; a reflective type liquid crystal panel; and a polarizer arranged between the light guide plate and the liquid crystal panel, the light guide plate, the polarizer, and the liquid crystal panel being bonded to one another;

wherein the polarizer and the light guide plate are bonded to each other with a first bond layer, the liquid crystal panel and a polarizing layer of the polarizer are bonded to each other with a second bond layer, and a thickness of the first bond layer serves as a structure for preventing or minimizing reflection or a part of the structure for preventing or minimizing

reflection.

41. A liquid crystal display device comprising: a light source; a light guide plate on which light emitted by the light source falls; a liquid crystal panel; and a polarizer arranged between the light guide plate and the liquid crystal panel, the light guide plate, the polarizer, and the liquid crystal panel being bonded to one another;

wherein a bond layer is arranged on the light guide plate, the polarizer includes at least a transparent layer and a polarizing layer, the transparent layer is arranged between the bond layer and the polarizing layer of the polarizer, and refractive index of the transparent layer is lower than refractive index of the light guide plate.

42. A liquid crystal display device comprising: a light source; a light guide plate on which light emitted by the light source falls; a liquid crystal panel; and a polarizer arranged between the light guide plate and the liquid crystal panel, the light guide plate, the polarizer, and the liquid crystal panel being bonded to one another;

wherein a thickness of a low refractive index area substantially forming a reflecting surface of the light guide plate serves as a structure for preventing or minimizing reflection of vertical light or corresponds to a half of the wavelength of the vertical light.

43. A liquid crystal display device comprising: a light source; a light guide plate on which light emitted by the light source falls; a liquid crystal panel; and a polarizer arranged between the light guide plate and the liquid crystal panel, the light guide plate, the polarizer, and the liquid crystal panel being bonded to one another;

wherein the light guide plate comprises a substrate and a resin layer, the substrate is made of the

same material as a substrate of the liquid crystal panel or a material whose coefficient of thermal expansion is generally equal to that of the substrate of the liquid crystal panel, the resin layer having a light path
5 changing capability of prisms for changing the path of light propagated through the light guide plate and emitting the light out of the light guide plate.

44. A liquid crystal display device comprising: a light source; a light guide plate on which light emitted
10 by the light source falls; a liquid crystal panel; and a polarizer arranged between the light guide plate and the liquid crystal panel, the light guide plate, the polarizer, and the liquid crystal panel being bonded to one another;

15 wherein a material of the light guide plate and a material of a substrate of the liquid crystal panel are glass or plastic.

45. A liquid crystal display device comprising: a light source; a light guide plate on which light emitted
20 by the light source falls; a liquid crystal panel; and a polarizer arranged between the light guide plate and the liquid crystal panel,

wherein prisms are formed on one side of the light guide plate, and the polarizer is bonded to the
25 opposite side thereof, the liquid crystal panel being driven according to the vertical alignment method.

46. A liquid crystal display device comprising: a light source; a light guide plate on which light emitted
30 by the light source falls; a liquid crystal panel; and a polarizer arranged between the light guide plate and the liquid crystal panel,

wherein prisms are formed on one side of the light guide plate, and the polarizer is bonded to the
35 opposite side thereof, the full angle of a spread angle at which light propagated through the light guide plate spreads over a horizontal plane falls within 60°.

47. A method of manufacturing a liquid crystal

display device comprising the steps of: bonding a
polarizer to a liquid crystal panel; bonding a light
guide plate to the assembly of the polarizer and the
liquid crystal panel bonded to each other; and pressing
5 the bonded unit of the light guide plate, the polarizer,
and the liquid crystal panel bonded in that order.

48. A method of manufacturing a liquid crystal
display device according to claim 47, wherein before the
light guide plate is bonded to the polarizer, the surface
10 of the light guide plate to be bonded is treated with
corona discharge, plasma deposition, or ultraviolet
irradiation.